

# Lowering the Risk of Neuropathy, Foot Ulcers and Amputations

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Peripheral neuropathy is one of the most common long-term complications of Type 2 diabetes. A population-based study in the north of England showed that 42 % of Type 2 diabetic patients had clinical evidence of neuropathy. The Diabetes Control and Complications Trial (DCCT) has shown that the incidence of neuropathy in Type 1 diabetes can be reduced by over 50 % with intensive therapy and optimal glycaemic control. Hyperglycaemia is believed to be a major aetiological factor in the development of neuropathy in Type 2 diabetes. Neuropathy cannot be diagnosed through history alone; therefore, careful examination of the feet for evidence of sensory loss and an assessment of the circulation must form part of the annual review of each patient. Peripheral somatic and autonomic neuropathy, together with peripheral vascular disease, are major contributing factors to the development of foot ulcers. In addition, abnormalities of foot shape (e.g. claw toes, prominent metatarsal heads) and the presence of plantar callus are signs of foot-ulcer risk. Effective patient education can reduce the incidence of foot ulceration and amputation by over 50 %; therefore, all patients with a high risk of foot ulcers should be informed and, if indicated, referred for regular podiatry. The team approach to diabetic foot problems is an effective method of providing treatment for active ulcers. This should be followed by appropriate education, the provision of follow up and if indicated, suitable footwear and hosiery. Key members of the team are the podiatrist, the specialist nurse and the orthotist; medical staff may include the diabetologist and a vascular or orthopaedic surgeon. Thus, the risk of foot ulceration and amputation can be reduced by careful screening and patient education, without the need for expensive equipment. © 1998 John Wiley & Sons, Ltd.

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## Introduction

The diabetic neuropathies represent the commonest long-term complication of Type 2 diabetes. The common chronic sensorimotor peripheral neuropathy, together with peripheral sympathetic dysfunction is discussed here but the mononeuropathies, autonomic and other polyneuropathies have been reviewed recently elsewhere.<sup>1,2</sup>

Neuropathies are characterized by progressive loss of nerve fibres, which can be assessed non-invasively using several tests of nerve function including electrophysiology, quantitative sensory testing and autonomic function tests. Although the natural history of diabetic neuropathy remains ill-defined, the late sequelae of the disease include foot ulceration, Charcot neuroarthropathy and in the worst cases amputation; however, these devastating problems are potentially preventable.

In this brief review the epidemiology, clinical features and potential prevention of sensorimotor neuropathy in Type 2 diabetes are discussed. Thereafter, the potential for reducing the risk of foot ulceration and amputation is described.

## Epidemiology of Neuropathy in Type 2 Diabetes

The quantity and quality of epidemiological data on diabetic neuropathy remain poor for several reasons including the definitions and diagnostic criteria employed, poor evaluation, and insufficient population-based studies. Chronic sensorimotor neuropathy is without doubt a common and important late complication. The few published population-based studies confirm the high prevalence of neuropathy in Type 2 diabetes patients; in the Rochester study, over 60 % of the cohort of randomly selected diabetic patients had clinical evidence of neuropathy although only 13 % were symptomatic.<sup>3</sup> In the north of England population-based study in Type 2 diabetes patients, over 40 % had significant neuropathy and were therefore at risk of insensitive foot ulceration.<sup>4</sup> In a similar study, approximately 1 in 20 patients in the north-west of England had past or present foot ulcers and 1.4 % were amputees.

In contrast to Type 1 diabetes, significant neuropathy may be present at the diagnosis of Type 2 diabetes. A regular clinical examination of the feet is therefore indicated at every clinical visit beginning from the date that diabetes is first diagnosed.

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## Clinical Features of Sensorimotor Neuropathy

The clinical presentation of sensorimotor neuropathy, the commonest of the diabetic neuropathies, is extremely variable and ranges from the severely painful ('positive') symptom at one extreme to the completely painless, which may present with an insensitive foot ulcer. Most patients experience symptoms at some point in the development of their neuropathy, although these may simply be 'negative' and comprise numbness or deadness in the lower limbs. Some of these symptoms most frequently encountered include burning pain, altered and uncomfortable temperature perception, paraesthesiae, and shooting, stabbing or lancing pain, hyperaesthesia and allodynia. The foot and lower legs are most commonly affected although some of the patients with long-term neuropathy may experience similar, but less severe, symptoms in the upper limbs.

Although the symptoms of sensorimotor neuropathy are generally sensory, in many cases the signs are both sensory and motor, with sensory loss in a stocking and glove distribution. To a lesser degree, sensorimotor neuropathy manifests itself as minor degrees of muscle wasting and occasionally weakness. The ankle reflex is often reduced or absent, and the skin of the foot is dry caused by frequently associated peripheral sympathetic dysfunction. Some patients report no symptoms, and therefore distal sensorimotor neuropathy cannot be diagnosed without a careful neurological examination.

## Reducing the Risk of Neuropathy

Peripheral neuropathies have been described in patients with primary (Type 1 and Type 2 diabetes) and secondary diabetes caused by diverse factors, which suggests a common aetiological mechanism based on chronic hyperglycaemia. The undoubted contribution of hyperglycaemia to neuropathy in Type 1 diabetes has received strong support from the Diabetes Control and Complications Trial.<sup>5</sup> In Type 2 diabetes the importance of hyperglycaemia in the development of progressive neuropathy has been confirmed in a 10-year study from Finland.<sup>6</sup> More recently, the United Kingdom Prospective Diabetes Study (UKPDS) has reported that those patients randomized to intensive blood glucose control with sulphonylureas or insulin had a significantly lower prevalence of neuropathy (using the surrogate endpoint of vibration perception) at the 9- and 15-year review than patients randomized to conventional therapy.<sup>7</sup>

The main aim of management in Type 2 diabetes patients with no evidence of neuropathy or very early changes should be the achievement and maintenance of optimal metabolic control. A number of therapies that may influence the natural history of neuropathy are at present under investigation but presently none is available on prescription in most countries.<sup>8</sup>

## Reducing the Risk of Foot Ulcers and Amputations: Aetiopathogenesis of Foot Problems

*'Coming events cast their shadows before'* (Thomas Campbell). Although not referring to diabetic foot problems, the Scottish poet's words can be applied to foot ulceration and amputation in diabetes. It is important to recognize the many shadows that may usefully predict those patients at potential risk of the coming events in the strong belief that intervention before the event with education, footwear, podiatry, appropriate hosiery and good diabetes care can substantially reduce the high incidence of these devastating complications.

Thorough understanding of the contributory causes that lead to foot ulceration is essential if the incidence of foot ulceration is to be reduced successfully, strategies for which have been covered in a recent detailed review.<sup>9</sup> The tissue breakdown of the foot has traditionally been considered a consequence of peripheral vascular disease, neuropathy and infection. However, no compelling evidence exists that infection is a direct cause; it is likely that infection becomes established after the initial ulceration has occurred.

Many studies have confirmed the high prevalence of arteriosclerotic peripheral vascular disease in diabetes, which remains a major contributory factor to foot ulceration. Somatic and autonomic dysfunction are also major contributory factors and because the onset of neuropathy is insidious, some patients may progress to the insensitive foot at very high risk of ulceration without ever experiencing symptoms. In contrast, some patients continue to experience painful symptoms when they have also developed peripheral insensitivity to external stimuli. A number of cross-sectional and prospective studies have strongly confirmed the importance of neuropathy in the genesis of ulceration.<sup>10</sup>

In addition to neuropathy and vascular disease, a number of other risk factors for foot ulceration exist. The presence of plantar callus has been shown to be associated with a 77-fold increase of ulceration at a callus site if peripheral insensitivity is also present.<sup>11</sup> Many studies have confirmed the importance of abnormalities of pressures and loads under the diabetic foot, and the aetiopathogenesis of ulceration. Other patients at high risk of ulceration include those with major complications, such as retinopathy and nephropathy, a past history of foot ulceration and those patients with a long duration of diabetes and poor control.

Although neuropathy and peripheral vascular disease are major causative factors for ulceration and amputation, the neuropathic or ischaemic foot does not ulcerate spontaneously. The combination of the high-risk foot with an environmental hazard often involving pressure externally, e.g. tightly fitting shoes, internally from callus, or from high foot pressures, may result ultimately in ulceration.

The vast majority of ulcers seen by the diabetologist, the specialist nurse, or the podiatrist are either neuropathic or neuroischaemic; few ulcers (15 %) are purely ischaemic. Therefore, a substantial reduction in ulceration and amputation may be achieved because these neuropathic and neuroischaemic ulcers can be prevented by early recognition, education and regular follow up in a high-risk foot clinic.

### Patient Education in the Prevention of Ulceration and Amputation

Two compelling reasons exist for why patient education in this area of prevention is important; first, several studies have confirmed a depressingly low level of understanding of foot problems among diabetic patients; and second, increasing evidence shows that targeted education reduces the incidence of ulceration and amputation.<sup>12</sup> The need to educate patients and healthcare professionals in the area of preventative foot care and diabetes is of paramount importance. Causal pathways that lead to amputation are well researched; a number of component factors usually combine to form a sufficient cause for amputations. Early identification of the 'at-risk' patient and their subsequent education may prevent the component causes all occurring together in one patient. In the area of preventative foot care, the team approach to the diabetic foot with the provision of foot care, regular education and treatment for those who develop problems, leads to substantial decreases in the frequency of amputations.<sup>13</sup> It is hoped that early recognition of at-risk patients and their inclusion in a preventative diabetic foot care programme will result in the achievement of the St Vincent goal, i.e. a reduction in the number of amputations in diabetic patients by at least 50 % within five years.

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